

October through December, 1959

IBM Technical Papers Published in Other Journals

Amphisbaenic Sorting, H. Nagler, *Journal of the Association for Computing Machinery*, **6**, No. 4, 459-468 (October, 1959).

A universal tape sorting method is described which requires only $p+1$ tape units as against $2p$ such units for conventional sorting methods (as for example in a p -way merge sort). The method requires only that magnetic tape can be read backwards. A new internal sorting technique, advantageous in special cases, is also described.

The AN/ASB-4 Bomb Nav System, K. J. Greif, *The Navigator*, **6**, No. 2, 12-13 (October, 1959).

A brief description of the AN/ASB-4 bombing navigation system, slanted to the navigator, pointing out the differences and advantages over previous systems.

Certain Aspects of Diffusion and Conduction in Alkali Halides,* E. A. Giess and T. J. Gray,† *Kinetics of High Temperature Processes*, J. Wiley & Sons, N. Y., 1959, pp. 11-13.

The apparently irreversible increased extrinsic diffusivity, as calculated from conductivity measurements, observed for natural halite (NaCl) after a high-temperature annealing treatment is also found in laboratory solution-grown "pure," "magnesium-containing" and "sulfate-containing" NaCl single crystals. This thermal history effect is not observed, at least not to such a significant degree, in melt-grown crystals which are representative of a high-temperature equilibrium state. Results are interpreted in terms of the thermal equilibrium of impurity solid-solubility and exsolution effects with dislocations functioning as sinks.

*Work done at Alfred University.

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Circle Networks of Probabilistic Transducers, M. Kochen, *Information and Control*, **2**, 168-182 (June 1959).*

A circle of devices is considered, each characterized by one-bit output which is statistically correlated with the outputs of its right and/or left neighbor at the preceding time period. It is shown that, provided no input-output relation is deterministic, this system will eventually become completely disorganized in the sense that it will behave like a collection of independent parts with completely unpredictable behavior. The rate at which this disorganization occurs under various conditions is calculated. A concrete version of this model is a sequential circuit of imperfect relays. A possible application to the determination of certain reliability parameters is given. The relation to a similar model for statistical mechanics by Kac is shown.

*For period April through June 1959.

Commande Numérique des Machine Outils, D. N. Chorafas, *L'Electricien*, **87**, 155-160 (August, 1959).*

This paper considers a complete example of numerical control of machine tools. The complete sequence of operations from blueprints to the manufacturing piece is first given by means of a flow chart, each block of which is explained. Specific examples of the respective operations, manned or automatic, are given. The structure of a minimal numerical control system is explained, and the alternative approaches to its conception and design are discussed.

*For period July through September, 1959.

A Comparison between the Evaporation Characteristics of a Crucible and a Ring Source, K. H. Behrndt and R. A. Jones, *1958 Fifth National Symposium on Vacuum Technology*, Pergamon Press, Inc., N. Y., **5**, 217-224 (October 16, 1959).

The properties of evaporated films largely depend on the uniformity of the evaporation parameters achieved during their deposition. Several types of evaporation sources have been investigated. In this paper, data on the crucible and the ring source as sources for evaporated films are presented, and their advantages and disadvantages are discussed. For both techniques, the experimental setup, the distribution of film thickness, and the variations of chemical composition over the area of a substrate are described in detail. The experimental results are compared with theory.

Computers for Tomorrow, D. N. Chorafas, *Operare* (Rome and Milan), **15**, No. 4, 28-32 (July-August, 1959).*

This article has been written specifically for business and industrial management in Italy. After an introduction to concepts in data processing and to the problem of intelligence, the discussion focuses on the classification of modern computing machinery. The structure of an electronic digital computer is considered from a minimal system to an expanded ensemble. The future of the computer is also discussed, including a consideration of real time control. Emphasis is given to the place of the computer in the medium to small enterprise.

*For period July through September, 1959.

On a Contamination Film Formed Prior to the Evaporation of Nickel-Iron in a Bell Jar, F. S. Maddocks and K. H. Behrndt, *1958 Fifth National Symposium on Vacuum Technology*, Pergamon Press, Inc., N. Y., **5**, 225-229 (October 16, 1959).

The magnetic properties of thin evaporated nickel-iron films are influenced by the surface condition of the substrate ma-

terial. Recent experiments have shown that a contamination film is deposited on the substrate prior to the evaporation of Ni-Fe *in vacuo*. This contamination film is not removed by common solvents, acids or mild physical abrasion. It has been found to occur only in the presence of molten Ni-Fe and is due to gases evolving from the melt. The crucible and other heated parts in the system, as well as pump oil vapors, have been eliminated as possible sources.

Experiments to determine the nature and cause of this film are described, and it is shown how the contamination film can be avoided.

Cyclotron Resonance in CdAs₂, Mirek J. Stevenson, *Physical Review Letters*, **3**, No. 10, 464-466 (November 15, 1959).

Cyclotron resonances of both holes and electrons were observed in *n*-type CdAs₂ single crystals pulled from melt of 99.999+ % purity. The higher effective mass resonance was identified with electrons by impact ionization and by filtering the exciting light source. The data is consistent with an energy band model consisting of single energy ellipsoids for both electrons and holes with effective mass parameters $m_e=0.57 m_0$, $m_h=0.16 m_0$ for electrons and $m_e=0.32 m_0$, $m_h=0.11 m_0$ for holes where the symmetry axis of the ellipsoids lies along the *c* axis.

A Demountable Glass Vacuum System Using Electron Bombardment in the Vacuum Deposition of Ferromagnetic Films, D. M. Hart, *1958 Fifth National Symposium on Vacuum Technology*, Pergamon Press, Inc., N. Y., **5**, 230-234 (October 16, 1959).

A demountable vacuum system for the deposition of ferromagnetic films, capable of a vacuum in the order of 10^{-8} mm Hg and using commercially available components is described. Features of the system include evaporation of an alloy wire by electron bombardment, substrate heating by an external infrared source, and utilization of the Kerr magneto-optic effect to study the magnetic properties of the deposited films under vacuum conditions.

On the Dependence of the Switching Time of Barium Titanate Crystals on Their Thickness, M. E. Drougard and R. Landauer, *Journal of Applied Physics*, **30**, No. 11, 1663-1668 (November, 1959).

The dependence of switching rate on the crystal thickness has been measured by Merz and explained by him in terms of a surface layer which has a low dielectric constant and is about 10^{-4} cm thick. While not explicitly stated in Merz' original arguments, the layer must have a reversible polarization. If a layer without a reversible polarization is assumed, instead, and the discontinuity of the normal component of polarization at the interface between the layer and the bulk is taken into account, then a much thinner layer (~ 1 atomic thickness) will explain the thickness dependence. This layer can be taken to be very lossy, so that it has a relaxation time (for the disappearance of electric fields) short compared to the switching time, and yet the layer will still be completely effective in slowing down domain wall motion.

Digital Computer Characteristics for Space Applications, G. C. Randa, *Electronic Equipment Engineering*, **7**, No. 10, 73-77 (October, 1959).

This paper deals with the characteristics of digital computers today as they might be applied to rocket, satellite and space-vehicle applications. Projections into the future are also made to predict, with estimated rates of change of these

characteristics, where the computer state-of-the-art will be five to ten years hence. Considered are the increases in packaging density as a result of new work in microminiaturization, increased computer speed available from faster circuits and memories, and computer component and machine reliability. Special attention is given to the reliability problem, with consideration of redundancy for improved reliability on long missions.

The Dissociation Pressure of ZnAs₂, V. J. Lyons, *Journal of Physics and Chemistry*, **63**, 1142-1144 (July, 1959).

Two standard methods have been employed to measure the dissociation pressure of ZnAs₂ in the range 612° to 770°C. A dew-point method was used from 612° to 759° and triple-point measurements covered the range 756° to 770°. The melting point of the compound was found to be $768 \pm 1^\circ$ at an arsenic pressure of 3.3 atmos. In the temperature range 612° to 740° the data may be represented by the equation $\log P = -12300/T + 15.0$. The heat of dissociation calculated from the slope of the equation is 18.8 kcal/mole.

Effect of Fission Recoil Fragments on the Thermal Conductivity of Graphite, L. P. Hunter, *Journal of Applied Physics*, **30**, No. 12, 1969-1975 (December, 1959).

The variation of the thermal conductivity of uranium-impregnated graphite is measured continuously while under neutron irradiation. The temperature is continuously monitored and results are reported which show the effects of the uranium oxide particle size, as well as the effect of the neutron bombardment, as separated from the fission recoil bombardment.

Effects of Polarized Light on Photocurrents and Photovoltages in ZnS, G. Cherooff, R. C. Enck, and S. P. Keller, *Physical Review*, **116**, 1091-1093 (December 1, 1959).

The anomalous short circuit photocurrents in ZnS have been measured using polarized light. In spite of the fact that for a given wavelength, light polarized perpendicular to the *c* axis is more strongly absorbed than light polarized parallel to the *c* axis, there are wavelength regions in which the absolute magnitude of the short circuit photocurrents are smaller for perpendicularly polarized light. The data are consistent with a double valence band model.

Fingers or Fists? W. Buchholz, *Communications of the ACM*, **2**, No. 12, 3-11 (December, 1959).

The binary number system offers many advantages over a decimal representation for a high-performance, general-purpose computer. The greater simplicity of a binary arithmetic unit and the greater compactness of binary numbers both contribute directly to arithmetic speed. Less obvious and perhaps more important is the way binary addressing and instruction formats can increase the over-all performance. Binary addresses are also essential to certain powerful operations which are not practical with decimal instruction formats.

On the other hand, decimal numbers are essential for communicating between man and the computer. In applications requiring the processing of a large volume of inherently decimal input and output data, the time for decimal-binary conversion needed by a purely binary computer may be significant. A slower decimal adder may take less time than a fast binary adder doing an addition and two conversions.

A careful review of the significance of decimal and binary number systems led to the adoption in the IBM STRETCH computer of binary addressing and both binary and decimal data arithmetic, supplemented by efficient conversion instructions.

Frequency Dependence of the Surface Resistance of Superconducting Tin in the Millimeter Wavelength Region, R. Kaplan,* A. H. Nethercot, Jr., and H. A. Boorse,* *Physical Review*, **116**, 270-279 (October 15, 1959).

The ratio of the superconducting to normal surface resistance of polycrystalline tin has been measured at seven frequencies between 17 kMc/sec and 77 kMc/sec and at temperatures from 1.5°K to 3.0°K. These data plus those of other investigators have been compared with the predictions of two theories: the first a calculation made by Serber (unpublished) based on the London two-fluid model of superconductivity and the Reuter-Sondheimer theory of the anomalous skin effect, and the second a calculation based on the Bardeen-Cooper-Schrieffer theory as developed by Bardeen and Mattis.

Agreement between experimental and theoretical results is only fair in the case of the two-fluid theory. The best values of the relevant parameters, Fermi velocity v and mean free path l , were found to be, respectively, $(1.25 \pm 0.3) \times 10^7$ cm/sec and 10^{-3} to 10^{-1} cm. A value of v of approximately 10^8 cm/sec would be expected for tin. The surface resistance ratio from the Bardeen-Cooper-Schrieffer theory has been calculated only for the extreme anomalous limit, and the calculation therefore should not apply too accurately for tin. However, a curve of the right general shape is obtained, and further calculations more appropriate to tin should improve the agreement between theory and experiment.

*Columbia University.

Flush Printed Circuitry — A Survey of Three Processes, L. N. Chellis, *Spectator*, **1**, No. 2, 30-36 (October, 1959).

Basic requirements of flush printed circuits are described which provide reliability and long life to sweep emitters, commutators, and other switching devices. The three processes presently being utilized for producing flush circuitry are reviewed. These are (1) the transfer process, (2) the molded process, and (3) the direct etching and flushing process. Production of circuits by these processes is illustrated, and some typical flush-printed-circuit applications for data-processing machines are shown.

Gibbs' Grand Canonical Ensembles, B. Mandelbrot, *Comptes Rendus de l'Académie des Sciences*, Paris, **249**, 1464-1466 (October 19, 1959). (In French).

It is pointed out that Gibbs' Grand Canonical Ensemble has an energy which is an infinitely divisible random variable, and that no other grand canonical ensemble has this property. This is used, as an additional axiom, to extend the theory of canonical ensembles provided by the author's phenomenological statistical thermodynamics.

On Information Theory in Science, Hideya Gamo, *Kagaku (Science)*, **29**, No. 10, 518-521 (October, 1959). (In Japanese).

Information theory developed in communication engineering may supply useful methods for studying various problems in science, such as optical image evaluation, human information-handling capacity, genetic coding in biological science.

Information processing problems peculiar to each field of sciences, however, cannot be solved only by the direct application of communication theory. Information theory in each field of sciences might be developed in conformity with conditions based on its own experimental facts.

Inter-Electron Collisions and the "Temperature" of Hot Electrons S. H. Koenig, *Proceedings of the Physical Society*, **73**, 959 (June, 1959).*

In a recent paper, Paige [*Proceedings of the Physical Society*, **72**, 921 (1958)] attempts to infer the electron "temperature" in n -type germanium at 77°K as a function of electric field by measuring the field dependence of the piezoresistance. Fundamental to the interpretation is the assumption that electron-electron scattering is sufficiently rapid to define a distribution function common to the electrons in all valleys. The present note (experimentally) shows this assumption to be incorrect, and suggests an experiment which will yield information on the electron temperature.

*For period April through June, 1959.

Internal Friction in Iron at Low Temperatures, L. J. Bruner,* *Physical Review Letters*, **3**, No. 9, 411-12 (November 1, 1959).

Internal friction measurements have been made in the range 4.2° to 350°K on annealed, cold-worked iron bars driven in a longitudinal mode of vibration at a resonant frequency of about 25 kc/sec. An electrostatic drive was employed and internal friction was measured by a free decay method.

It appears that in iron the dislocation relaxation peaks characteristic of fcc metals are absent or at least very much attenuated. The results on iron are atypical in that the internal friction increases with decreasing temperature, reaching a maximum at around 50°K and maintaining that value to the lowest temperature reached.

A new mechanism is suggested based upon the thermally activated motion of symmetric paired partial dislocations between vacancy-pinning points; minimum energy configurations are those for which the vacancy is immediately above either partial. The activation energy is determined by the energy required for the transition (by glide of the dislocation pair) between the two stable states.

*Work done at Institute for the Study of Metals, University of Chicago.

Introduction to Numerical Control, D. N. Chorafas, *Industrial Review Magazine* (Athens), **26**, No. 299, 35-37 (September, 1959).*

This article has been written for industrial management. It constitutes an introduction to present-day numerical control means and procedures with most emphasis on the numerical control of machine tools. The article presents an appraisal of present-day techniques and discusses their impact on the future of manufacturing industry.

*For period July through September, 1959.

Isotopes Effect in the Bardeen-Cooper-Schrieffer and Bogoliubov Theories of Superconductivity, James C. Swihart, *Physical Review*, **116**, No. 1, 45-52 (October 1, 1959).

It is shown that the Bardeen-Cooper-Schrieffer and Bogoliubov theories of superconductivity predict an isotope effect which is the same for all superconductors, so long as the Coulomb interaction is neglected. This is demonstrated by writing the system of integral equations in a mass-invariant form, and it does not involve finding actual solutions. The

theories predict that H_0 , T_c , and the energy gap at $T=0$ are proportional to $M^{-1/2}$. The inclusion of the Coulomb interaction destroys the invariance of the equations and introduces deviations from the $-1/2$ in the exponent. The magnitude of the deviation depends on the particular superconductor considered.

Law of Corresponding States in Superconductivity, James C. Swihart, *Physical Review*, **116**, No. 2, 346-347 (October 15, 1959).

It is shown by means of a crude calculation that a refined version of the Bardeen-Cooper-Schrieffer theory of superconductivity in which the energy gap function $\mu(\nu)$ would not be approximated by a constant would give very nearly the same relation between H_0 , the critical field at $T=0$; $2\mu(0)$, the energy gap; and $N(0)$, the density of states at the Fermi surface. Agreement between the theory and experiment is found for the cases of Al, Sn, Hg, and Pb, although the experimental error is large for Hg. For the case of Pb, this is the first agreement between the theory and experiment with regard to the thermodynamic variables.

Machine Learning, A. L. Samuel, *Technology Review*, **62**, No. 1, 42-45 (November, 1959).

Popularized version of paper which appeared in *IBM Journal of Research and Development*, **3**, No. 3, 210-229 (July, 1959).

Mirror Anastigmat with Two Concentric Spherical Surfaces, P. Erdős, *Journal of the Optical Society of America*, **49**, No. 9, 877-886 (September, 1959).*

A description is given of a two-mirror system suitable for imaging a small polychromatic light source at finite distance. The system consists of two concentric spherical surfaces, convex and concave, respectively. Third-order, spherical aberration, coma, and astigmatism are cancelled. Fifth-order aberrations are calculated explicitly to permit the computation of construction parameters and mounting tolerances according to the image quality required. A numerical example is given.

*For period July through September, 1959.

Modified Alligator Clips Simplify Component Testing, F. J. Scott, *Electrical Design News*, **4**, No. 12, 59 (December, 1959).

This article describes an alligator clip modified for use as a tool for dielectric strength tests and insulation resistance measurements of components such as resistors, capacitors, and diodes.

Multiprogramming STRETCH: Feasibility Considerations, E. F. Codd, E. S. Lowry, E. McDonough, and C. A. Scalzi, *Communications of the ACM*, **2**, No. 11, 13-17 (November, 1959).

The tendency towards increased parallelism in computers is noted. Exploitation of this parallelism presents a number of new problems in machine design and in programming systems. Minimum requirements for successful concurrent execution of several independent problem programs are discussed. These requirements are met in the STRETCH system by a carefully balanced combination of built-in and programmed logic. Techniques are described which place the burden of the programmed logic on system programs (supervisory program and compiler) rather than on problem programs.

Nonresonant Nuclear Spin Absorption in Lithium, Sodium, and Aluminum, A. G. Anderson, *The Physical Review*, **115**, 863-868 (August 15, 1959).

Audio-frequency spin absorption has been observed in the nuclear spin systems of the metals lithium, sodium and aluminum. In lithium and sodium, the observed second moment of the absorption line at zero dc magnetic field is in agreement with calculations assuming only magnetic dipole-dipole interactions; in aluminum the zero-field absorption extends to frequencies as high as 50 kc/sec, and the second moment of the absorption line appears to be about 50% larger than expected. Spin absorption has also been observed at small applied dc magnetic fields, H_0 , for audio-frequency magnetic excitation both parallel to and perpendicular to H_0 . In both of these cases, absorption occurs at νH_0 and $2\nu H_0$ in agreement with theory.

A Note on Professor Mannes' "Dominance" Theorem, R. E. Levitan, *Management Science*, **5**, 332 (April, 1959).*

A gap in the proof of the Dominance Theorem in Mannes' previous paper in this Journal is pointed out and filled.

*For period April through June, 1959.

The Numbers Generated by $\exp(\arctan X)$, R. P. Kelisky, *Duke Mathematical Journal*, **26**, 569-581 (December, 1959).

The arithmetic properties of numbers and polynomials which satisfy certain second-order-linear difference equations with nonconstant coefficients have been discussed by several writers. The numbers of the title satisfy a difference equation which is a special case of the difference equation,

$$u_{n+1} = f(n)u_n + g(n)u_{n-1},$$

where $f(n)$ and $g(n)$ are polynomials with integral coefficients and $g(0)=0$. This difference equation was apparently first discussed from an arithmetic viewpoint by Leonard Carlitz in connection with the arithmetic properties of the classical polynomials of analysis. Four corollaries are given in this paper which follow from a general theorem due to Carlitz concerning this difference equation. Several theorems concerning arithmetic properties of the numbers of the title are obtained. Their most interesting property is that if p denotes an odd prime, then

$$T_p \equiv \begin{cases} 0 \pmod{p} & \text{if } p=4n+1 \\ 2 \pmod{p} & \text{if } p=4n+3. \end{cases}$$

Numerical Error Checking, E. T. Klemmer, *Journal of Applied Psychology*, **43**, No. 5, 316-320 (October, 1959).

Speed and accuracy of numerical error checking were studied as a function of the probability of randomly placed errors and horizontal grouping of the digits. The speed of checking was highest for groupings of three or four digits and fell off for larger or smaller groups. Accuracy did not vary with grouping. Speed of checking varied inversely with error probability, but the increased speed at low error probability was accompanied by a higher percentage of undetected errors so that information handled was invariant with error probability.

Optical Spectra of Rare Earth Activated BaTiO₃, S. P. Keller and G. D. Pettit, *Journal of Chemical Physics*, **31**, 1272 (November, 1959).

BaTiO₃ has been activated with either Pr, Sm, Eu, Dy, or

Er ions. The fluorescence spectra were determined at -196°C , -28°C , room temperature, and at 130°C . We looked for crystalline field effects on the energy levels of the rare earths and changes in these effects as the crystallographic phase of BaTiO_3 is changed. In particular, we sought changes at the Curie point in going from the ferroelectric tetragonal phase to the cubic phase. The high temperature data were largely unresolvable and no changes were observed at the low temperature transitions in going from the tetragonal to the orthorhombic phase in the range of 5 to 13°C and from the orthorhombic to the rhombohedral phase in the range of -70 to -80°C . No crystal field splittings were observed at any temperature, leading to the possible conclusion that the rare earth centers are in positions of either high symmetry or low field strength. The fluorescence data support the hypothesis that the rare earths are present as the trivalent ions and that they can be assigned energy levels and term signatures resulting from the $4f^n$ configuration.

Paper and Board Insulation, T. D. Callinan, *Insulation*, **5**, No. 12, 13-14 (December, 1959).

The most significant advance in paper and board insulation during the last decade was the commercialization of paper products made entirely from such synthetic fibers as glass, ceramic and metal.

Based on present demand, the production of dimensionally-stable, non-embrittling, light-weight cellulose-based papers and boards will epitomize the advance in this field during the next decade.

Pareto-Lévy Random Variables and Processes, B. Mandelbrot, *Comptes Rendus de l'Académie des Sciences*, Paris, **249**, 613-615 and 2153-2155 (Part I: August 3, 1959; Part II: November 23, 1959). (In French).

Pareto-Lévy random variables are stable variables with finite means, infinite variance, and maximal skewness. They were tabulated, and are shown to provide an interpolation to the classical family of laws of Pareto; in fact, this interpolation gives a better fit to the data than does the law of Pareto itself. Processes based upon the multidimensional law of Pareto-Lévy are constructed; it is shown that, for large values of the variable, such processes approximate a random walk of $\log U(t)$. Three reasons are given, for the applicability of the "Pareto-Lévy" theory, to the data which are usually represented by the law of Pareto.

A Photo-Magnetic System for Document and Information Retrieval, P. James, *American Documentation*, **10**, No. 4, 286-295 (October, 1959).

This article describes an information retrieval system in which alterable digital information on magnetic tape is associated with documents on film. The proposed storage medium consists of microfilm striped with magnetic tape or separate but matched rolls of magnetic tape and microfilm. Responses to inquiries are photomagnetically reproduced onto an output tape in any predetermined order. Any number of complete document sets and, if desired, a variable number of the individual frames within a set can be obtained as an in-line function through suitable programming. A novel technique is incorporated for updating the photographic file as a part of the retrieval operation.

Polarizabilities and Antishielding Factors of 10 and 18 Electron Closed Shell Atoms, G. Burns, *Journal of Chemical and Physics*, **31**, 1253-1255 (November, 1959).

Polarizabilities and antishielding factors are obtained for a number of ions that have 10 and 18 closed shell electron configurations. Certain empirical relationships are found so that other polarizabilities and antishielding factors can be deduced. The results using Hartree and Hartree-Fock wave functions are also compared.

Polarized Light Transmission of BaTiO_3 Single Crystals, R. C. Casella and S. P. Keller, *Physical Review*, **116**, 1469 (December 15, 1959).

Optical transmission and reflection measurements were made on poled BaTiO_3 single crystals in the tetragonal phase (crystal class C_{4v}) with light polarized parallel and perpendicular to the c axis. The absorption coefficients, $\mu_{\parallel}$ and $\mu_{\perp}$ are presented as functions of the incident photon energy at room temperature. At the absorption edge, $\mu_{\perp} > \mu_{\parallel}$. A theoretical basis for this selection rule, which has been derived from first principles, is granted. The theory represents a generalization of earlier work of wurtzite crystals and extends the applicability of the wurtzite selection rule to all solids in the crystal classes, C_{nv} and C_n , where $n=3, 4$ or 6 . Limitations of the theory are discussed. The dichroic effect in BaTiO_3 has also been studied experimentally at elevated temperatures, in the vicinity of the Curie point. It is concluded that the extrema of the valence and conduction bands of BaTiO_3 probably lie at (or very close to) the origin of the Brillouin zone.

Resistance Transitions in Superconducting Tantalum*, D. P. Seraphim and R. A. Connell, *Physical Review*, **116**, No. 3, 606-612 (November 1, 1959).

A study has been made of the superconducting to normal transition in outgassed tantalum wires induced by the application of an external longitudinal magnetic field. It was found that in most cases the transition, as determined from resistance measurements, consisted of an almost discontinuous appearance of resistance; followed by a rather gradual rise in resistance until the full residual resistance was restored. Flux measurements showed that the sharp portion of the transition corresponded to the magnetic, or "bulk" transition. The behavior of the broad portion of the transition was of the type commonly associated with superconducting "filaments." Although the "filamentary" properties were found to be extremely sensitive to localized contamination and the thermal history of a specimen, they did not appear to depend exclusively on such inhomogeneities, and a systematic variation with residual resistance could be discerned. Plastic deformation altered the characteristics only in proportion to the corresponding increase in residual resistance. A small amount of supercooling which was independent of the "filamentary" phenomena was sometimes observed in the "bulk" transition.

*This work was supported in part by the Department of Defense.

The Role of Vacancies in an Unusual Anelastic Phenomenon, B. S. Berry, *Acta Metallurgica*, **7**, 741-745 (November, 1959).

The internal friction results obtained by Entwistle from a number of quench aging Al alloys are re-examined and interpreted. Two transient contributions to the internal friction are observed on aging duralumin near room temperature. The first contribution develops during the initial hardening, and is deduced to be of anelastic origin. It is suggested that this contribution occurs by a stress-induced rearrangement of clusters of solute atoms and at a rate greatly accelerated by the presence of excess vacancies. The second contribution, which develops considerably later in the aging sequence, is also a relaxation phenomenon but with a shorter

relaxation time governed by an activation energy of 13.5 kcal/mole and a frequency factor of 10^{14} sec⁻¹. This later relaxation is thought to arise from a stress-induced rearrangement of small groups of solute atoms containing vacant lattice sites as an integral component of their structure. This model successfully explains the salient experimental results and leads directly to the interpretation of the activation energy as that for vacancy motion. The observed sequence of changes indicates that the relaxation centers responsible for both contributions occur within the G.P. zones, and that a spontaneous reorganization within the zones is responsible for the changeover from one contribution to the other.

Self-Adjustment of Internal Radiation Field to Compensate for Linearly Varying d Spacing in X-Ray Diffraction, H. Cole and G. E. Brock, *Physical Review*, **116**, No. 4, 868-874 (November 15, 1959).

It is now well known from studies of "anomalous transmission" that the energy flow through a perfect crystal during symmetric Laue (transmission) diffraction is along the diffracting planes. If the planes are then fanned out, as in elastic bending, the question arises as to whether or not the radiation pattern can adapt itself to the changing d spacing so as to maintain diffraction conditions. If it does, the exit Bragg angle should differ from the entrance Bragg angle by an amount proportional to the bend. Experimental evidence is presented to show that this is indeed the case. Germanium crystals, judged to be perfect because of lack of etch pits, were used. Various anomalies in the transmitted intensities indicate that defects still exist.

Self Diffusion and Nuclear Relaxation in He³, R. L. Garwin and H. A. Reich, *Physical Review*, **115**, No. 6, 1478-1492 (September 15, 1959).*

Direct spin-echo measurements of diffusion coefficient (D) and spin relaxation time (T_1 and T_2) have been performed on He³, with an accuracy $\sim 2\%$ in the range 0.5°K to 4.2°K and at pressures to 67 atmos in the liquid, the solid, and in dilute solutions of He³ in He⁴. Unactivated diffusion is observed to the lowest temperatures in the liquid, but not in the solid. By measurement of D at 19 atmos we find an activation energy of 13.7°K for the production of scatterers in He II. There is an extended discussion of experimental details.

*For period July through September, 1959.

Superparamagnetism, Nonrandomness, and Irradiation Effects in Cu-Ni Alloys, F. M. Ryan,* E. W. Pugh, and R. Smoluchowski,† *Physical Review*, **116**, No. 5, 1106-1112 (December 1, 1959).

The effect of neutron irradiation on copper-nickel alloys has been investigated by means of magnetic susceptibility measurements. The susceptibilities were measured by the Gouy method between 300°K and 2.0°K for a series of alloys ranging from 17.22 to 46.5 atomic percent nickel. It is shown that without superparamagnetism an unreasonable magnetic moment per nickel atom has to be assumed. This model is confirmed by irradiation studies in which samples were exposed to neutron fluxes at the Brookhaven reactor, ranging up to 2.2×10^{19} neutrons/cm² while at 80°C, and the magnetic susceptibilities were found to increase following the irradiation. The increase was easily observable due to its strong temperature dependence, and was greatest for the samples with the highest nickel content and for samples exposed to the highest neutron fluxes. The susceptibilities of the alloys returned to their original values following an anneal in or above the temperature range where self-diffusion becomes important, while no changes in the susceptibilities

were observed following anneals at lower temperatures. It is suggested that the copper-nickel system is not a perfect random solid solution but tends toward segregation, and that the neutron irradiation enhances diffusion toward a true equilibrium at room temperature. This is in agreement with several other observations.

* Westinghouse Research Laboratories, Pittsburgh
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Thermal Oscillations in n-type Germanium at Low Temperatures, S. H. Koenig and R. Brown, *Journal of Physics and Chemistry of Solids*, **10**, 201-203 (July, 1959).*

The low-temperature breakdown in germanium is shown to be unstable under certain circumstances. The instability occurs when a small increase in current in part of the sample produces a local temperature rise which cannot be dissipated before it in turn causes a further current increase. The instability generally results in thermal relaxation oscillations of the sample with associated electrical relaxation oscillations of the measuring circuitry. The oscillations cause an effective negative resistance to appear when dc measurements are made in the usual manner. The operation of the low-temperature bi-stable negative resistance device (now called a CRYOSAR), discussed in the Lincoln Laboratory Quarterly Reports, is presumably of a similar nature.

*For period July through September, 1959.

Thin Magnetic Films for Memory and Switching Elements, W. E. Proebster, *Elektronische Rechenanlagen*, **1**, H. 4, 164-171 (November, 1959).

Thin magnetic films—some 100 atom layers thick, some millimeters long and wide—promise many advantages as storage and switching elements compared to conventional magnetic materials. The practical application of thin films, however, requires the study of their physical behavior. Theoretical predictions of the static and the dynamic behavior are compared with experimental results. In particular, the coherent rotation of the magnetization lasting about 10^{-9} sec is emphasized. For computer memories with thin magnetic films, which are now about to be applied for the first time, the cycle times obtained being some 0.1 μ sec are mainly determined by the drive- and read-circuitry. For the application of thin magnetic films to switching circuits the rapid change of the magnetization is essential. Pulse and carrier systems ("parametron") are discussed here. Finally hard magnetic films are described, which deserve interest as read-only memory of high capacity.

A Transistorized Automatic D-C Beta Tester, E. P. Hojak, *Electronics*, **32**, No. 49, 114-115 (December 4, 1959).

This article describes the features of a circuit which automatically sets up the biased conditions for measuring the dc gain of a transistor. The circuit employs transistors in a feedback system. Good accuracy and fast operation make this circuit applicable to transistor testing.

Use of Paramagnetic-Resonance Techniques in the Study of Atomic Oxygen Recombinations, S. Krongelb and M. W. P. Strandberg,* *Journal of Chemical Physics*, **31**, 1196 (November, 1959).

A method of making measurements of atomic recombination times with a paramagnetic-resonance spectrometer is described. The theory of the paramagnetic-resonance spectrometer applied to these measurements is presented. Meth-

ods for using both diffusion and flow systems for determining surface and volume recombination coefficients are analyzed. The operation of the system that was used is illustrated for atomic oxygen recombination. The surface recombination coefficient for oxygen atoms on a quartz surface is shown to be 3.2×10^{-4} per collision and the second-order volume recombination coefficient was less accurately determined as $5 \times 10^{15} \text{ cm}^6 \text{ mole}^{-2} \text{ sec}^{-1}$. The measurement of the diffusion coefficient of atomic oxygen is described. The possible application of these methods to further study of reaction rates is discussed.

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Variation of the Latent Heat of the Cubic Tetragonal Transformation in the System $\text{K}\text{a}\text{B}\text{O}_3\text{-K}\text{TaO}_3$, John J. Hall* and S. Triebwasser, *Journal of American Chemical Society*, **81**, 6394 (December, 1959).

Measurements of the latent heat of transition of ceramic samples of $\text{KTa}_x\text{Nb}_{(1-x)}\text{O}_3$ from the tetragonal to the cubic phase are reported for values of the parameter x ranging from 0 to 0.18. The latent heat is observed to decrease rapidly as x is increased from zero. The method of sample preparation, apparatus and experimental procedures are

described briefly. On the basis of certain simplifying assumptions, the spontaneous polarization at the ferroelectric Curie point is calculated, using the phenomenological theory proposed by Devonshire.

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Wave Propagation in a Liquid Layer, D. T. Liu, *Geophysics*, **XXIV**, No. 4, 658-666 (October, 1959).

In many areas offshore, the conventional seismic record has the appearance of a series of sine waves or simple odd harmonic combination of sine waves, with a fundamental wavelength four times the water depth. Burg et al, in a ray-theory treatment, ascribe this oscillatory phenomenon to guided energy traveling in the water layer.

A solution of the pressure wave equation for a point source in the water layer has been obtained. It allows one to examine not only the frequency dependence with the depth, but also the transient amplitude response with depth and time.

It is concluded that in most actual situations, the phenomenon cannot be wholly explained by the assumed mechanism, because the theory indicates too rapid a decay of the energy.